Fresh Energy

Climate Change and Minnesota's Water Resources

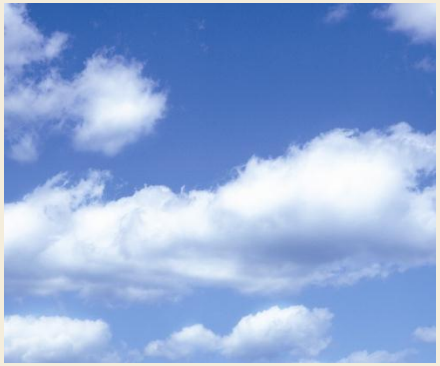
J. Drake Hamilton

Science Policy Director

Fresh Energy's mission and vision

Shape and drive realistic, visionary energy policies that benefit all.

Fresh Energy promotes an economy we thrive in and energy that ensures our well-being.




Energy Made in Minnesota

- Science-based policies
- Keeping more dollars in our state
- Clean water and clean air
- Growing markets in efficiency, wind and solar energy

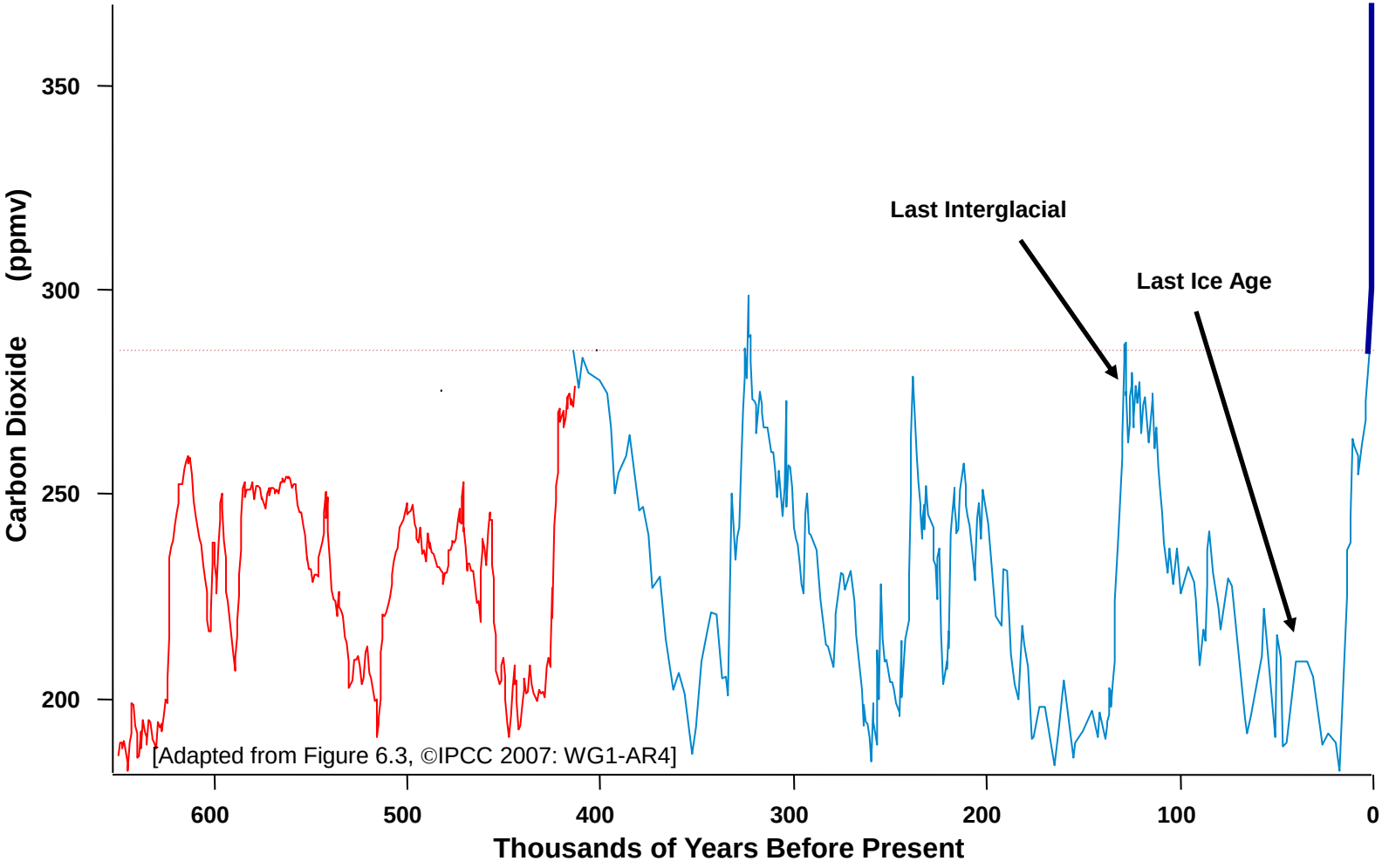
Climate governs (and therefore, climate change affects):

- availability of water
- productivity of farms, forests, & fisheries
- prevalence of oppressive heat & humidity
- formation & dispersion of air pollutants
- geography of disease
- damages from storms, floods, droughts, wildfires
- property losses from sea-level rise
- expenditures on engineered environments
- distribution & abundance of species

Climate change puts all of these at risk.

Prof. John Holdren's 2008 keynote address to the National Council on Science and Environment

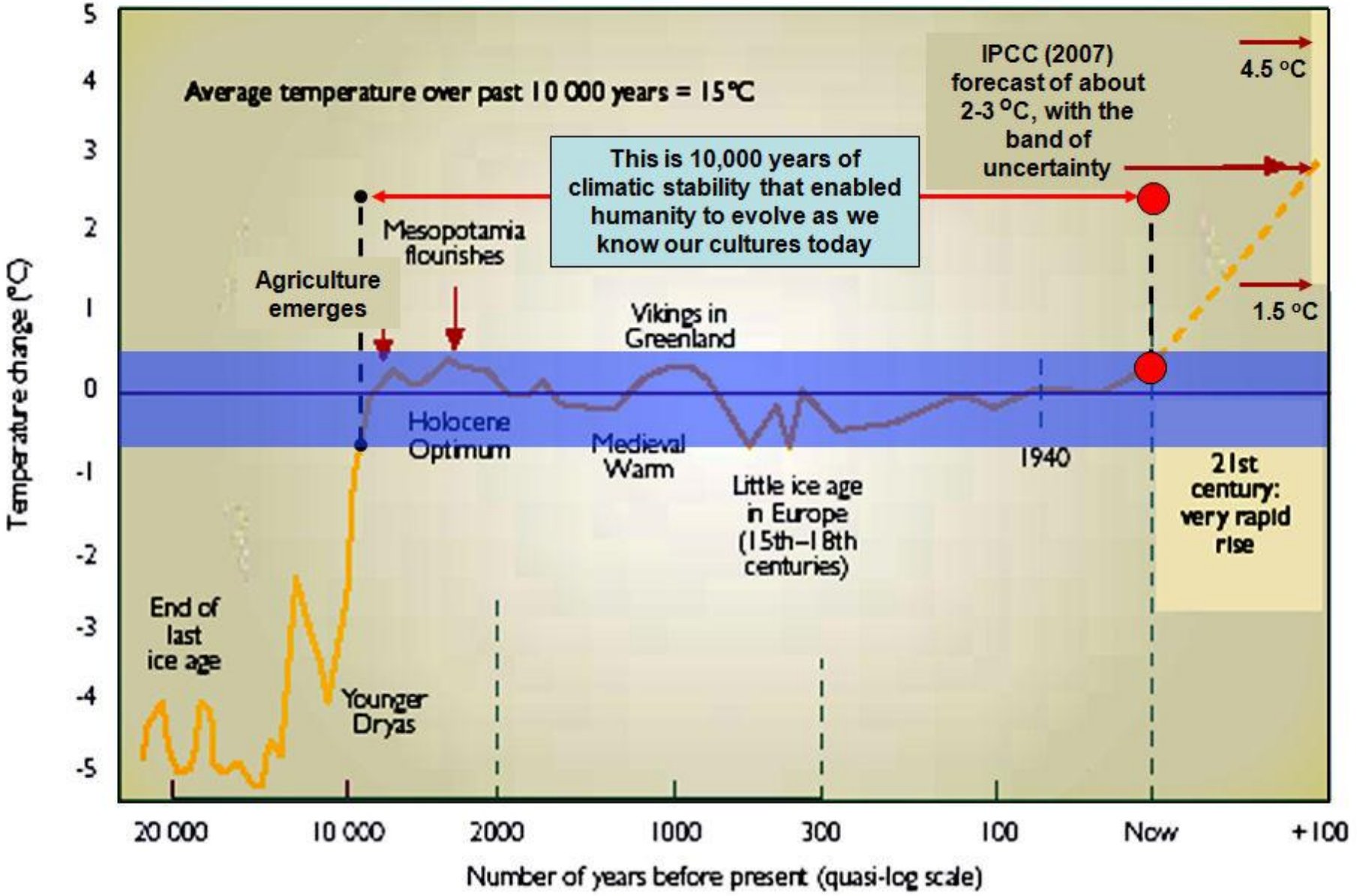
http://belfercenter.ksg.harvard.edu/files/2008_1-17_NCSE_final.pdf

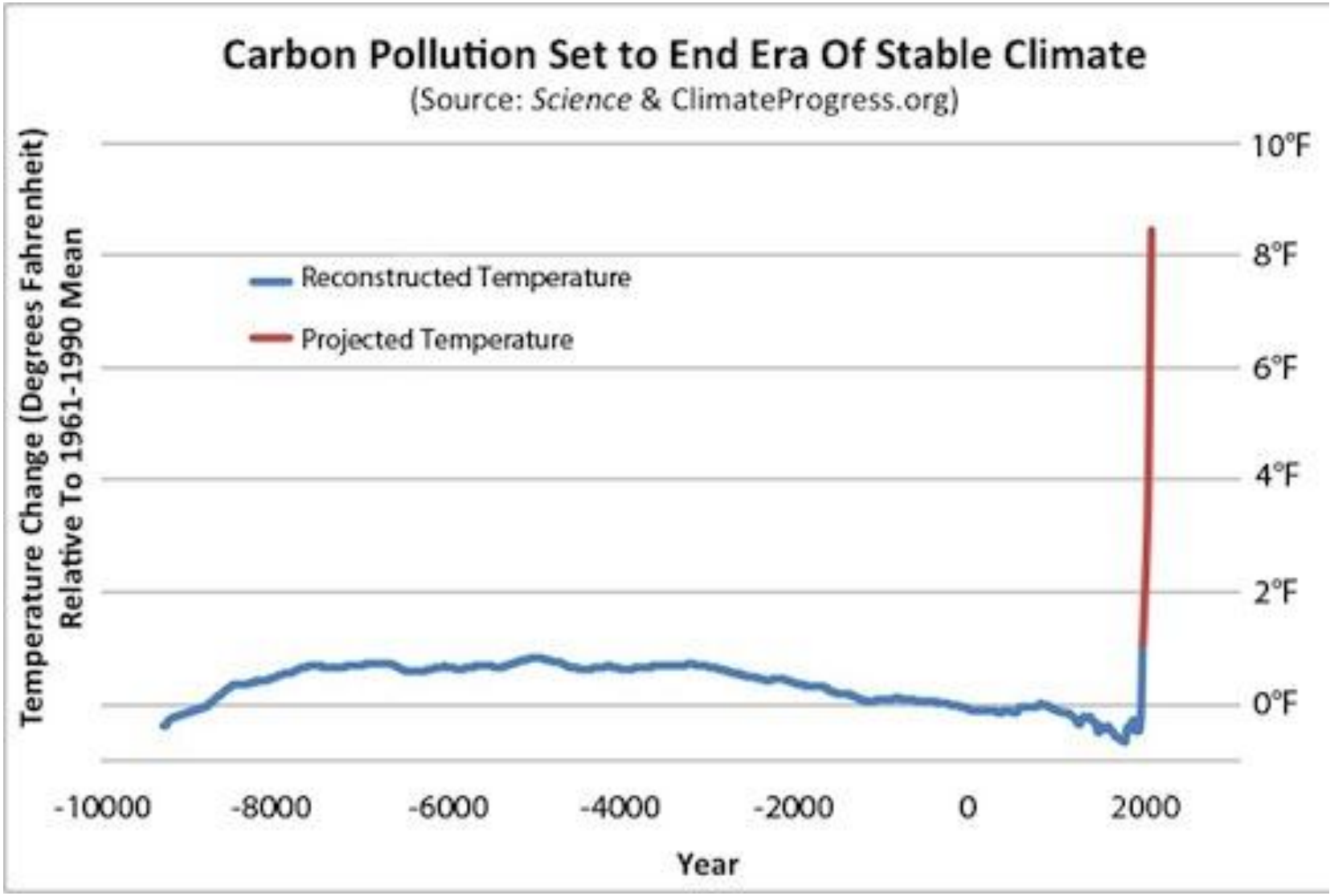


Ice ages are not random. They are 'forced' (by earth's orbital clock…. changes in the sunlight received).

Humans are 'forcing' the system in a new way. CO_2 increases are mainly due to fossil fuel burning. CO_2 has not been this high in more than half a million years.

The Last 20,000 Years seems to have been Ideal for the Development of Human Societies. Is this a Historic "Sweet Spot" that Enabled Humans to Flourish?

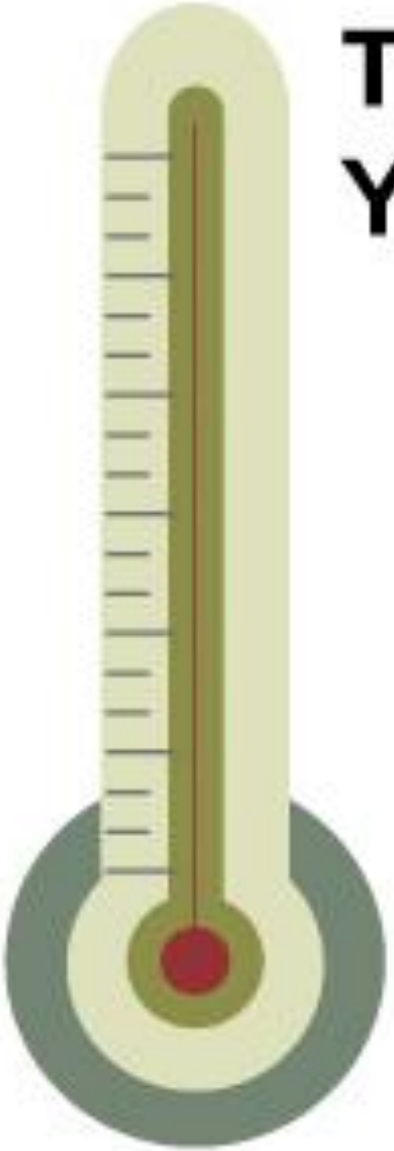



Carbon Pollution Set to End Era Of Stable Climate
(Source: Science & ClimateProgress.org)
Temperature Change (Degrees Fahrenheit)
Relative To 1961-1990 Mean
Reconstructed Temperature
Projected Temperature
10°F
8°F
6°F
4°F
2°F
0°F
-10000
-8000
-6000
-4000
-2000
0
2000
Year

NASA and the National Oceanic and Atmospheric Administration confirm from global data, a 345-month consecutive string of warmer-than-average months:

NASA and the National Oceanic and Atmospheric Administration confirm from global data, a 345-month consecutive string of warmer-than-average months:

Anyone under the age of 28 has never lived through a cooler than average month on earth.



THE WORLD'S 11 HOTTEST YEARS ON RECORD

1. 2010
2. 2005
3. 1998
4. 2003
5. 2002
6. 2006
7. 2009
8. 2007
9. 2004
10. 2012
11. 2011

The National Academy of Sciences, May 2011

"Global climate change caused by human activities is occurring now, and it is a growing threat to society…

the time to control greenhouse gas emissions is now."

Reality and Responsibilities

- Global warming is real, serious, and man-made.
  - The overwhelming majority of climate scientists agree.
- The warming climate already is causing significant impacts to people and ecosystems.
- There is an urgent need for action: Choices we make now can reduce the severity of future impacts.

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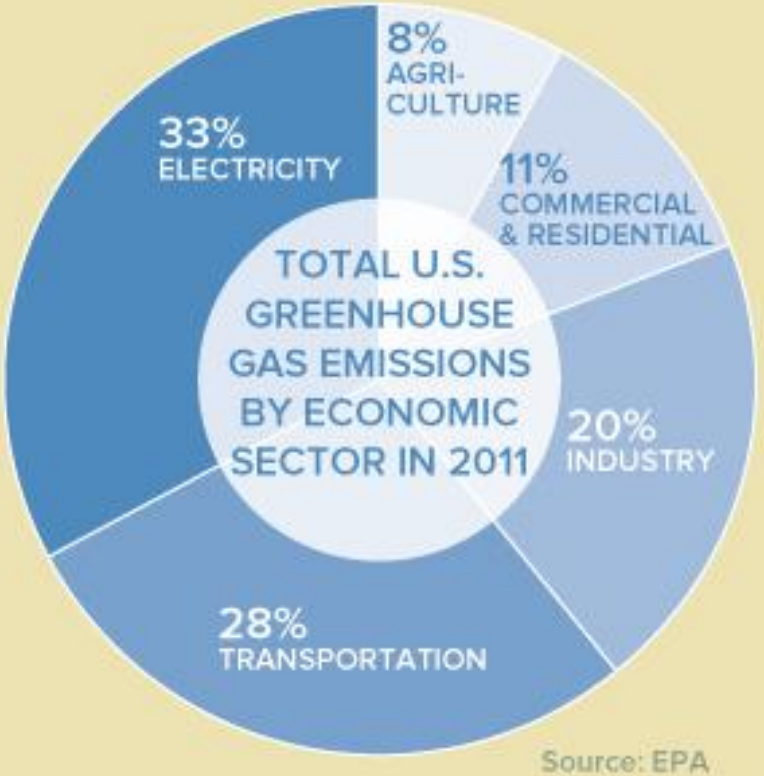
CAUSES

HUMAN ACTIVITY

The amount of carbon in the Earth's atmosphere has increased by 41 percent since the beginning of the industrial era, primarily due to burning fossil fuels like coal, oil, and natural gas.



Source: EPA

ACTIONS MATTER

CLEAN CARS

The most important action the United States has taken yet to cut carbon pollution.

THE CLEAN AIR ACT

Eighty-seven percent of Americans support Environmental Protection Agency action to reduce carbon pollution.

INVESTMENT IN EFFICIENCY

When businesses and residents save energy through efficiency, it eliminates the need to produce more power, saving money and cutting carbon at the same time.

54.5

The miles per gallon set by clean car standards by 2025

10

The number of power plants that Xcel Energy has not needed to build, thanks to efficiency

Minnesota's energy policy foundation

NEXT GENERATION ENERGY ACT

- Double/triple energy efficiency investments
- 25 percent by 2025 Renewable Electricity Standard
- Science-based limits on our carbon pollution

Next Generation Energy Act of 2007

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Science-based Minnesota goal to reduce carbon pollution from 2005 levels at least

15 percent by 2015

30 percent by 2025

80 percent by 2050

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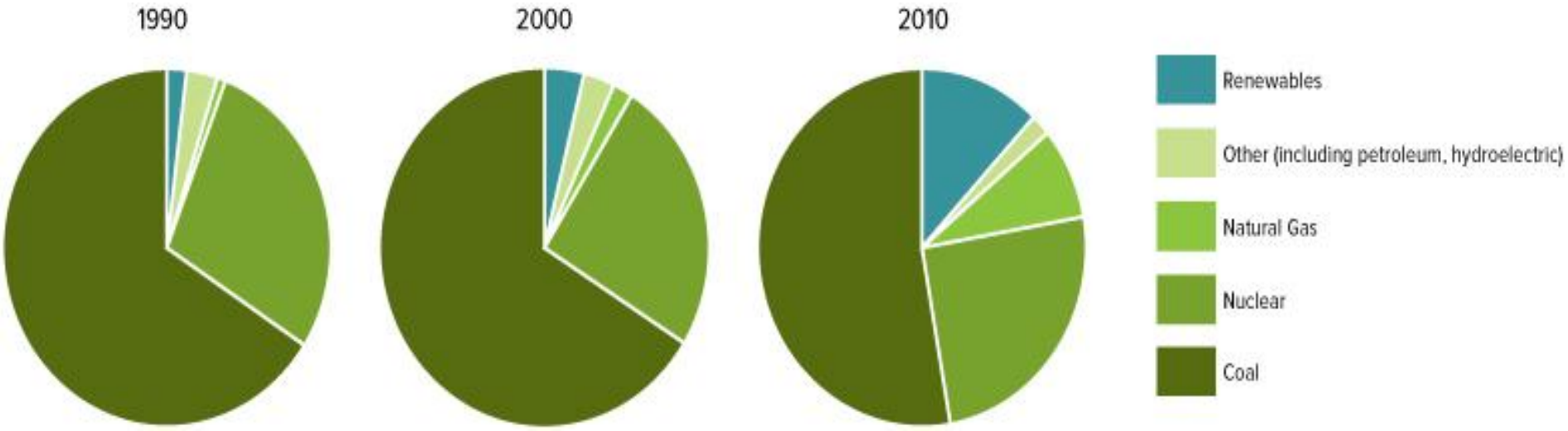
25 percent by 2025
Renewable Electricity Standard

Minnesota electricity generation by fuel type



Source: Energy Information Administration data 1990-2010

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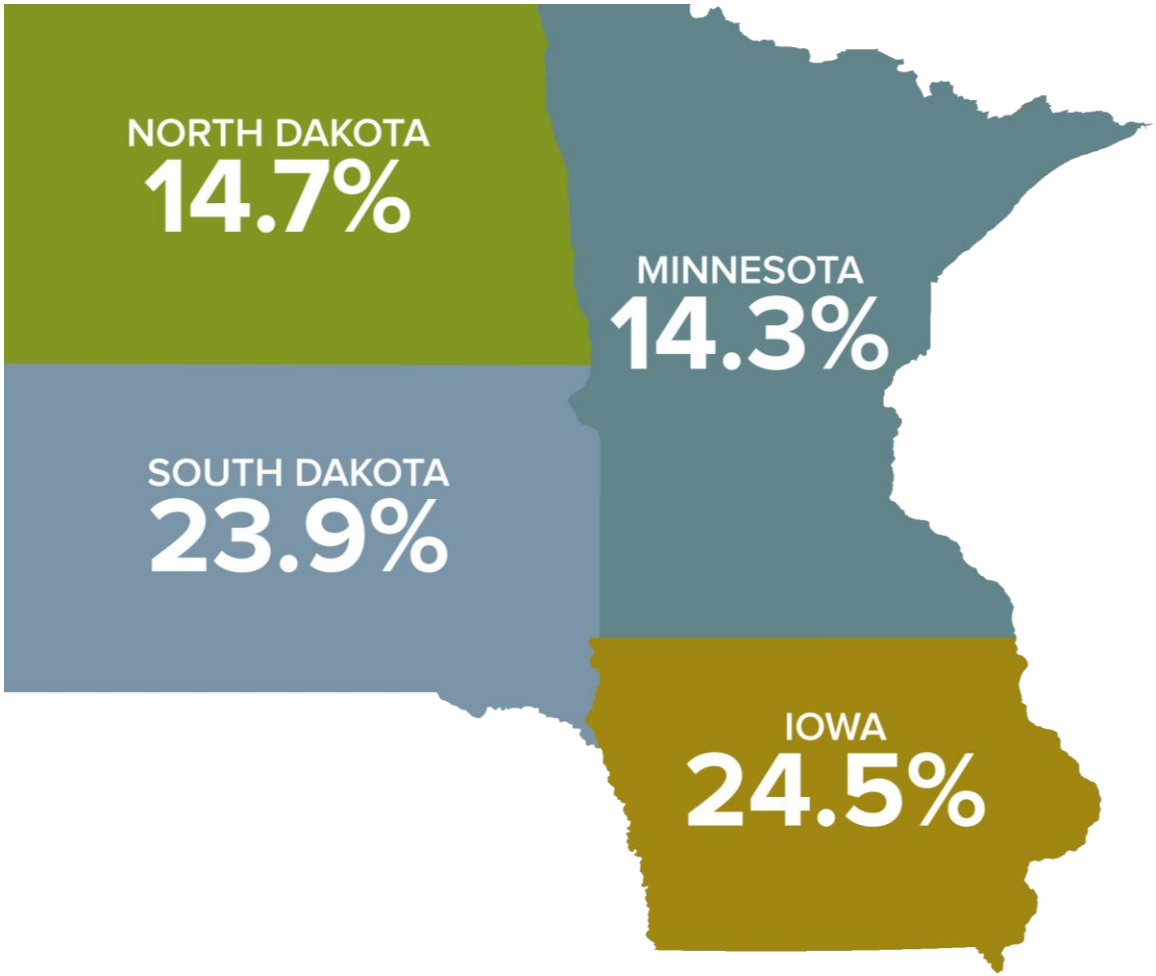
Minnesota has a great wind resource

Percent of electricity from wind power, 2012



Source: American Wind Energy Association

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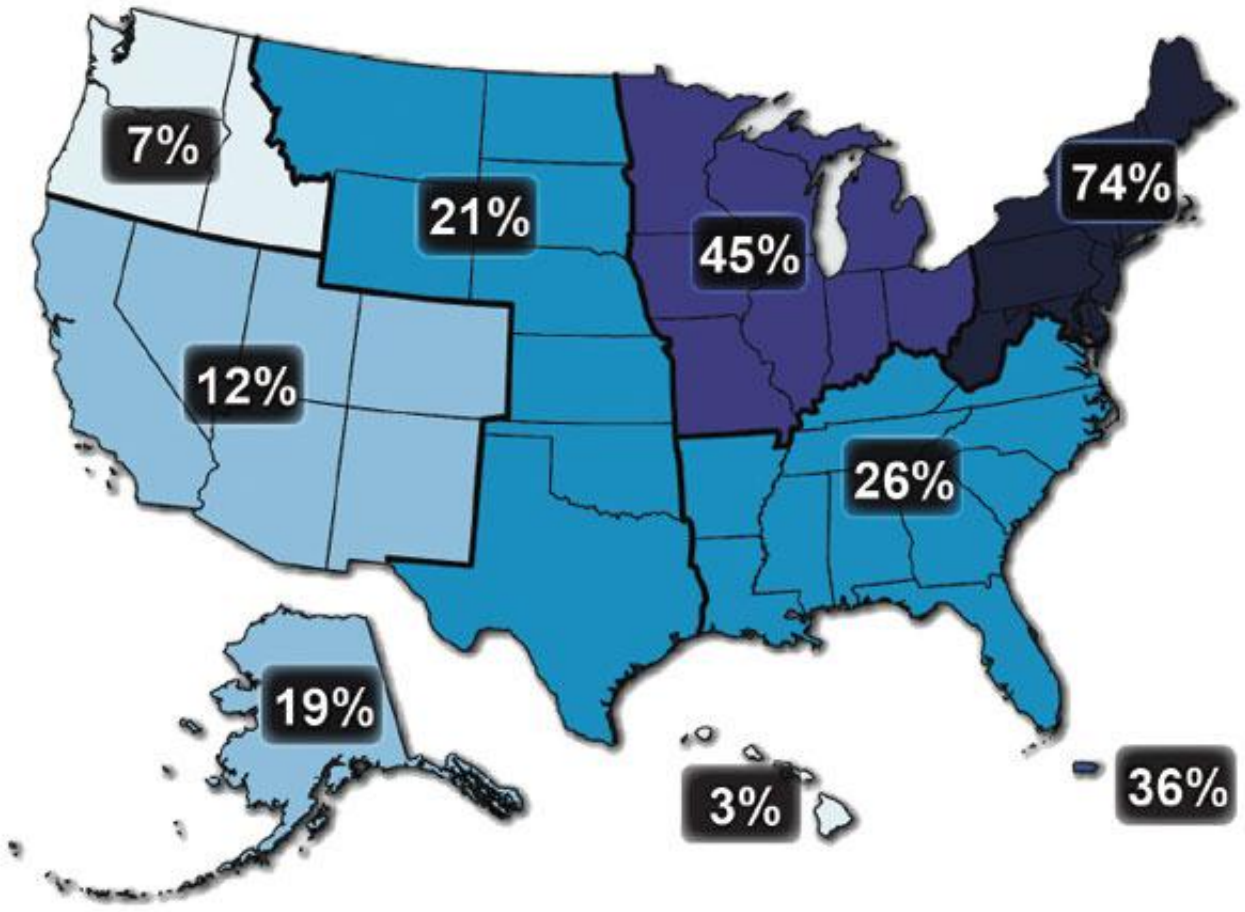
1.5 percent solar energy by 2020

But Our Work is Not Done

Percentage change in very heavy precipitation, 1958-2011



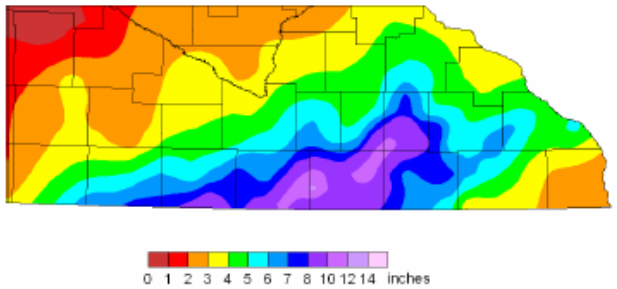
Source: 2013 National Climate Assessment draft report

Three one –in-1,000 year events since 2004

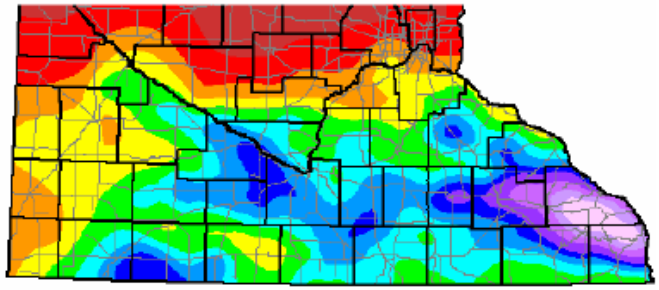
MN State Climatology office

'1000-yr (approx.) events' in Southern Minnesota in the last decade.

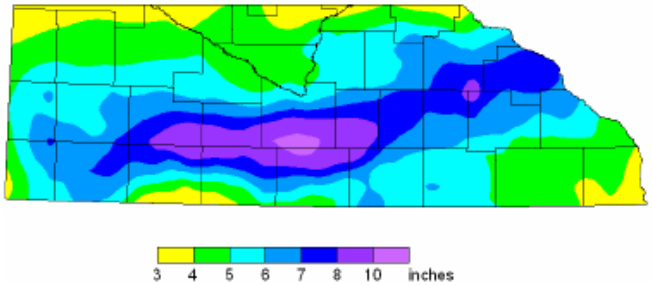
September 14-15, 2004



August 18 through August 20 (8:00 AM CDT), 2007



September 22-23, 2010



A 'by-eye' estimate of the total area covered by 10" of rain over the 7 years of 2004-2010 appears to be near 1400 sq. mi. or about 200 sq. mi per year. Given that the area of the southern 3 layers of counties looks to be approximately 20000 sq. mi. the areal fraction of the southern three counties covered by 10" per year appears to be approximately 1/100; i.e. at the rate of coverage for the last 7 years an area equal to the whole southern three county area could be covered in about 100 years.

Minnesota Impacts

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Source: Minnesota State Climatologist

- **Increased air and water temperatures**
- **Reduced ice cover**
- **More extreme weather (EXPENSIVE weather): floods, droughts, heat waves, wildfires**
- **More frequent droughts reduce stream flows and kill streamside vegetation**

Minnesota Impacts

Fresh Energy

- Habitat loss for many cold-water species
- Exacerbation of existing stressors, such as habitat loss, polluted water, invasive species, and pathogens
- Increased competition from warm-water species
- Changes in fisheries management (stocking, fishing opener, etc)

Minnesota Impacts

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Amplified moisture variability—tile drainage, irrigation, water supply systems, impaired waters

Increased soil erosion

Later fall nitrogen applications (soil temp too high)

Minnesota Impacts

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Minnesota has had a 100-150 mile northward shift in vegetation since 1980: red maples, Jack pine, black spruce, balsam fir, aspen…

Minnesota moose, deer, black bear, elk already significantly impacted

(“Nowhere to Run: Big Game Wildlife in a Warming World” – the National Wildlife Federation, Nov 2013)

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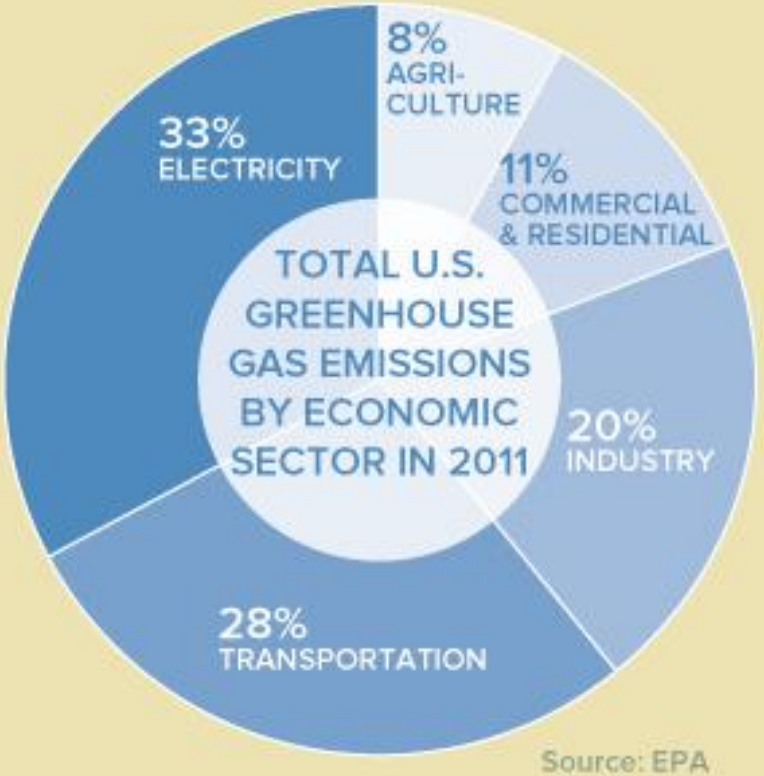
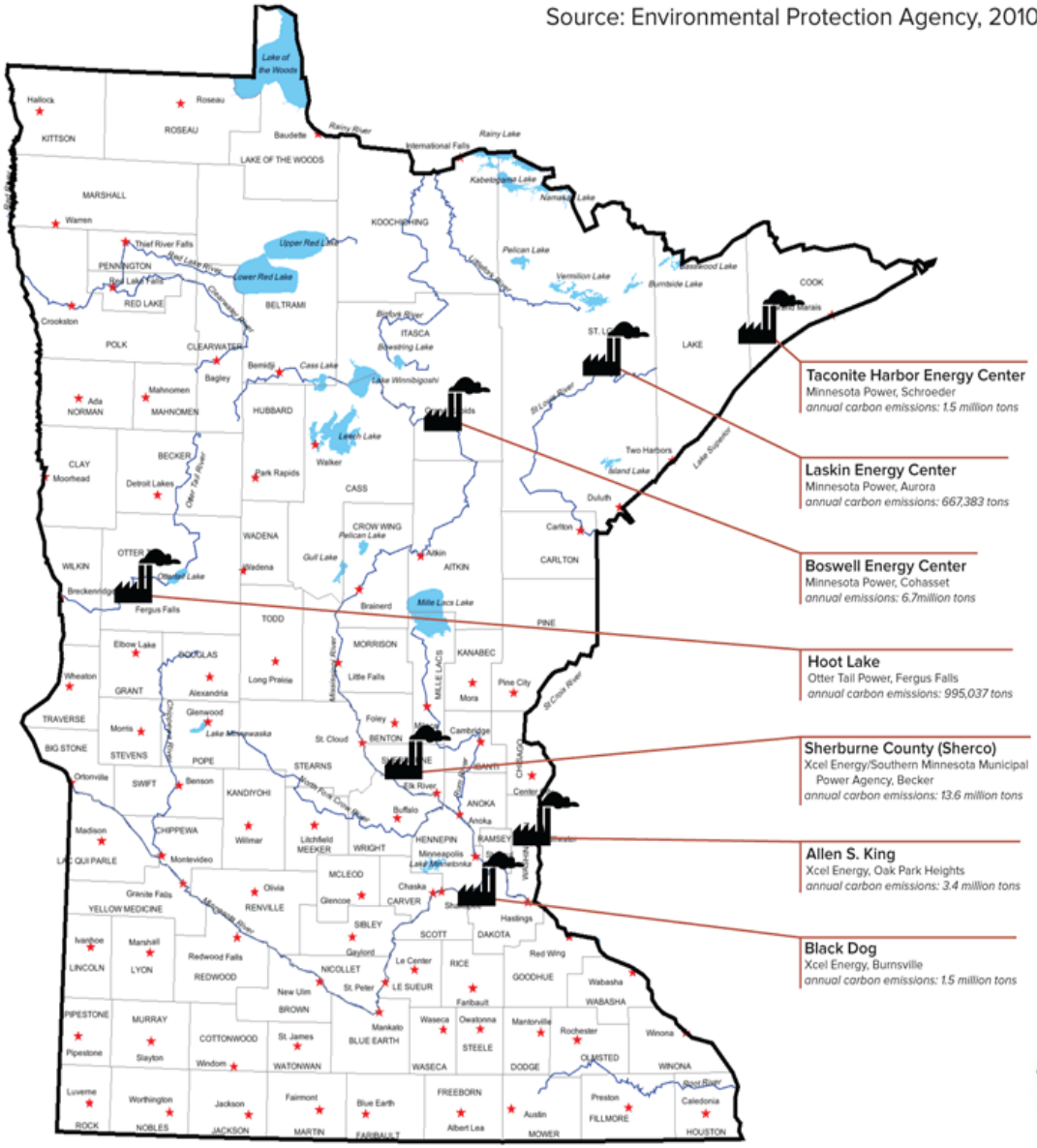


Source: EPA

Minnesota's worst coal plant carbon polluters

Source: Environmental Protection Agency, 2010 data



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Sherco: Minnesota's largest carbon polluter

- 13.6 million tons CO2 in 2010
- 411 pounds of mercury
- Burns 3 trainloads of coal per day

Xcel Energy, July 1, 2013

In every scenario where Xcel considers a reasonable cost on carbon pollution from the plant, it makes more sense to retire than to invest and continue to operate.

The real costs of burning coal

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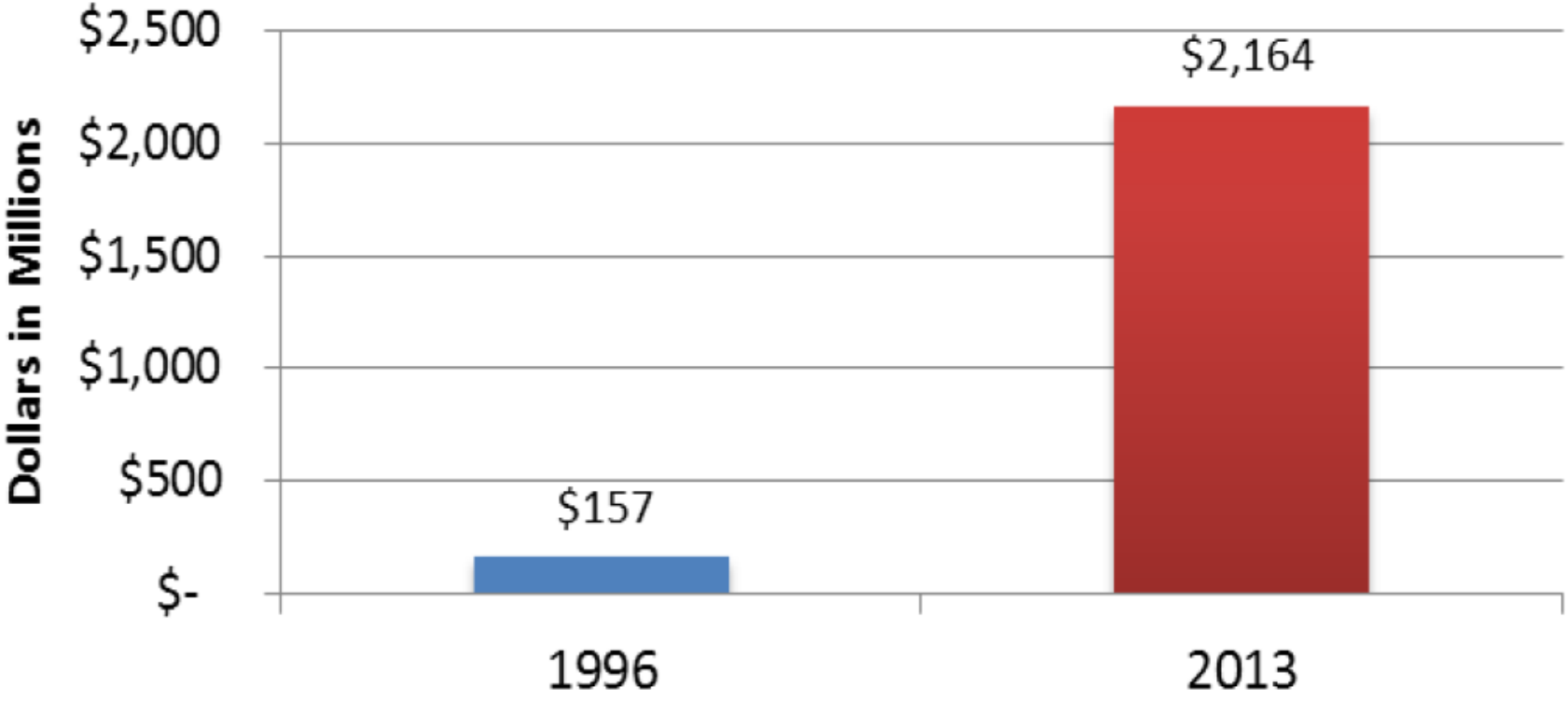
At minimum, $2.1 billion a year in Minnesota

CO2, fine particulate pollution, SO2, NOx

1992 law requires state to include externalities costs in electricity investment decisions

Minnesota PUC voted 4-1 in December to require updates to reflect current science

Total (Mid-Range) Damages from Electricity Generation in Minnesota (SO_2, NO_x, $PM_{2.5}$, and CO_2)



Data: June 15, 2013 Order, Docket No. E-999/CI-93-583 and E-999/CI-00-1636 ("mid-range" value represents midpoint between low and high values adopted in 1996 and adjusted for inflation); Goodkind & Polasky, *Health and Environmental Costs of Electricity Generation in Minnesota* (September 26, 2013).

Clean Air Act standards

President Obama's Climate Action Plan

Directs the Environmental Protection Agency to speed the modernization of the nation's electrical grid.

- Halt the "limitless dumping of carbon pollution" from coal-burning power plants into our air.
- Building on 4 decades of steady, responsible, common-sense safeguards.

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The Clean Air Act: Human health and welfare

- There are no nationwide limits—none-- on carbon pollution from power plants.
- The Clean Air Act requires the Environmental Protection Agency to limit pollutants that harm human health and welfare.
- Supreme Court: **carbon dioxide and other greenhouse gases are pollutants that must be limited to protect human health**

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Reality and Responsibilities

It’s never too late—

It is always cheaper to do something about climate change than to do nothing.

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Response Strategies

Get at the root of the problem and cut carbon pollution

- Use and protect proven, existing laws to tackle carbon pollution
- Prioritize clean, efficient energy and reduce fossil fuel use
- Protect and restore natural carbon sinks

Design, fund, and carry out climate-smart conservation strategies

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